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About the Cover

NASA's Large Format Camera (LFC), the latest development in space/aerial systems, photographed Boston from an altitude of 148 miles during its debut flight. Evident are Logan Airport, primary and secondary street patterns, major buildings and harbor shipping.

A high resolution mapping camera incorporating advanced optical and electronic systems, the LFC flew on mission 41-G in October 1984 and took more than 2,000 pictures including areas of every continent.

LFC data will be used for mapping, geology and other applications with the added capability of three-dimensional analysis to allow accurate measurement of heights.

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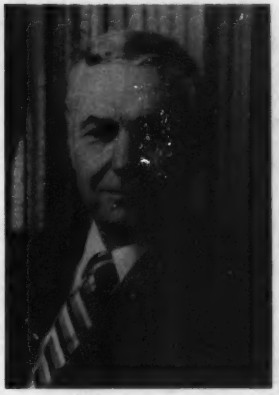
Administrator's Column

(In this column NASA Activities features an article by NASA Administrator James M. Beggs. These articles focus on subjects chosen by him that address topics of broad interest to the agency's employees. The column this month features an address presented at the Georgetown University School of Foreign Service symposium on science, technology and diplomacy held in Washington, D.C.)



The Potential for Science and Technology

A few months ago, I received a telephone call. A voice explained very courteously the benefits I could receive from new insurance. And it asked me, at the tone, to provide my age, income and insurance level. This call was from a machine. I daresay this impertinence would have had me slamming the phone down if I had answered it. But I did not. I was not home and the call went into another machine — my answering machine.

So, for two minutes, two machines conversed.

Now, I am an engineer, and probably would be among the last to speak ill of or discard any of the technological wonders that decorate our lives today. Indeed, I believe strongly that technology not only pushes science forward, but has been responsible for much of the social and economic progress in the world today.

But I also believe that scientific and technological advances have come into our lives so rapidly that we tend to take them for granted. As a consequence, we forget they sometimes lack the human touch, as my little story illustrates. Clearly, if we are to use science and technology to our advantage, we have to find ways to replenish that lack, both in our interpersonal and in our international relationships.

One way, for example, is to use telecommunications technology to reinforce the bonds that join us to other times, places and people — to reaffirm our common humanity.

We need to be reminded from time to time that we share the Earth with many people and many other forms of life.

The Apollo program did this, and did it very successfully. The live television image of man's first landing on the moon on July 20, 1969, was seen around the world. It moved our Librarian of Congress, Archibald Macleish, to write a poem in which he called the world's peoples "Riders on the Earth Together." Indeed, the first photos of Earth from beyond our planet revealed to us, as nothing else could, our common heritage. They brought home to people everywhere that we are one people together, on one Earth in a vast universe. Thus, they sparked a movement — the environmental movement — to preserve and protect our natural resources.

Apollo marked our coming of age as a space-faring nation. It symbolized the increasing role of science and technology in shaping our values and our lives, not only on Earth, but in space as well.

Today, you can't pick up a newspaper or watch the television news without noticing that science and technology issues play an increasingly important role in international relations. They are the stuff of international disputes, international collaboration and international interest. In short, they have become the stuff of diplomacy. Clearly, then, they cannot be divorced from our foreign policy concerns.

Nowhere is that more apparent than in my field, the new world of space.

And yet, despite the fact that science and technology and the space program are inextricably linked to foreign policy issues, we fail to use them to full advantage as foreign policy tools. And this is because we still have no coherent and ongoing mechanism to integrate both our leadership in space and our high technology advantage into the fabric of diplomacy and foreign policy. We need to use these leverages more effectively. Indeed, I hope this symposium will address ways to overcome this very important problem.

To get a better idea of what has been happening, let's look at three critical areas of current foreign policy concerns: East-West relations; the North-South dialogue; and international cooperation. In all three, we can see how science and technology, as reflected in space technology and operations, plays a highly visible role.

As for the first — the East-West relationship — it is clear that the high ground of space has taken on a sharp profile in our relationships with the Soviet Union. The

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recent Geneva talks between the United States and the Soviet Union underscored the fact that both sides have concerns about space weapons.

At the same time, both sides use space to gather information about each other and to verify compliance with vital peacekeeping agreements. And under the Outer Space Treaty of 1967, both sides even go so far as to let each other know, through the United Nations, when they have launched a satellite and where it will fly in space. Neither, however, is required to disclose the spacecraft's mission or its capabilities.

On the civil side, we have had a variety of cooperative efforts by the U.S. and the U.S.S.R. in space. The most visible was the Apollo Soyuz Test Project in 1975, during which our respective spacecraft docked in orbit.

We are also involved in a multilateral satellite-aided search and rescue system with the Soviets. The system detects ships and aircraft in trouble, and so far has been credited with saving about 300 lives. And we have had many exchanges on biomedical research findings, particularly on the human body's adaption to space flight.

Future East-West cooperation in space exploration could be a fertile field as well. Here the United States and the Soviet Union share similar interests, which extend even to sending manned expeditions to explore Mars some day. And U.S.-Soviet cooperation in such an endeavor could certainly enhance the cause of peace in the world.

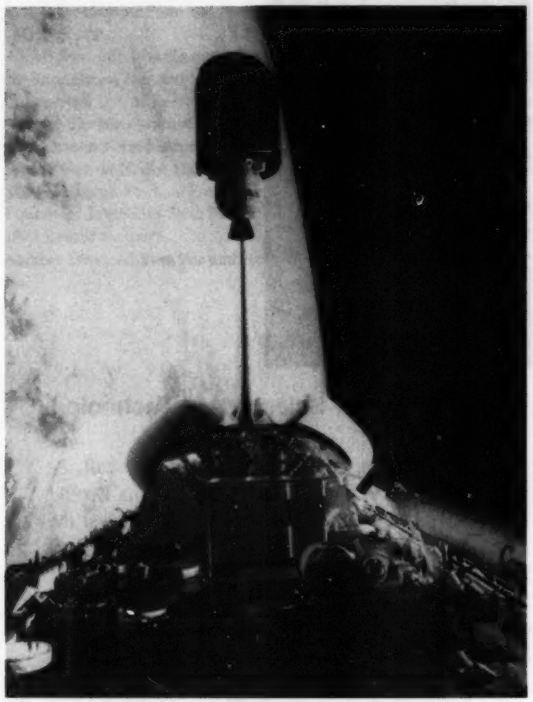
Recently, President Reagan invited the Soviets to join with the United States in undertaking a joint manned mission using the Shuttle and the Salyut spacecraft. So far, the Soviets have not accepted this offer, but if they were to accept, we could probably work it into our Shuttle schedule within a year. We would like to do it, and it would demonstrate our capabilities to work peacefully together in space.

So space, as one component of science and technology, occupies a prominent role in the East-West diaglogue. And I believe it will continue to do so, well into the future.

Turning to North-South issues, it is clear, too, that Third World societies have become increasingly concerned about both the impact and promise of science and technology.

Most developing countries were not involved in space activities a decade or so ago, because they probably viewed space as an area of interest only for the developed nations. But this is no longer the case. The revolution in satellite technology has made it possible for many Third World nations to respond effectively and quickly to vital domestic communications needs.

I have already spoken of telecommunications technology as a force for greater international understanding. And nowhere is this more evident than in the relationships between the developed and the developing nations of the world. Just as a nation like Indonesia, with its thousands of islands, can unite its people and territory through communications satellites, so that technology can help to bring Indonesia and other developing nations more fully into the global community. And Third World countries are starting to use it to do just that.



The Indonesian satellite, Palapa B, is deployed from the Shuttle.

The lesser developed countries also have found that space technology can be a valuable tool for economic development. Remote sensing from space has revealed hitherto unknown sources of natural resources and even reservoirs of water to be tapped for irrigation. Crop rotation and all forms of agriculture, fishing, mining and other industries have benefited from space observations.

At the same time, the Third World has become increasingly concerned about how current and planned space systems might affect them adversely. For example, they fear that data from remote sensing satellites could be used by foreigners to identify valuable resource deposits in their countries for the

purpose of exploitation. They are also apprehensive that all the "parking places" in geosynchronous orbit will be filled by communications satellites from the developed countries before Third World nations get their fair share.

Small wonder then, that we see increased activism from Third World representatives at such forums as the International Telecommunications Union and the United Nations Committee on the Peaceful Uses of Space.

International cooperation in space — our third area of concern — is becoming increasingly important. The National Aeronautics and Space Act, which created NASA in 1958, charged the agency to cooperate with other nations in space activities and to share the benefits of space research. And we have done that. Since the Act became law, NASA has entered into more than 1,000 agreements with some 130 nations and international organizations. These relationships have covered a full spectrum of collaborative endeavors, ranging from space hardware development to sharing of mission data with scientists around the globe.

We are starting to put together the largest international space project in history — the design, development and operation of a permanently manned Space Station, which we expect to be operating in the early 1990s. President Reagan invited our friends and allies to join with us on this project, and while there are still many problems to be resolved, I am confident they will do so.

Both we and our friends agree that the Space Station will be of incalculable benefit to all participating nations.

While these examples have had to be brief, I hope my point is clear. And that is that developments in science and technology have a strong impact on virtually every broad area of traditional diplomacy. And their influence is snowballing.

And as science and technology continue to make their influence felt across the board in international affairs, the people who do the work have been affected as well. On the one hand, diplomats and foreign policy specialists have had to deal more and more with science and technology matters. And on the other, technologists and scientists have moved into areas where their work can truly influence foreign policy decisions.

Twenty-six years ago, C.P. Snow warned of an unbreachable "gulf of mutual incomprehension" between humanists and scientists in his famous Rede lecture, "The Two Cultures and the Scientific Revolution." He went on to say that this gulf is so broad that not only do the two cultures not understand each other but, like people who are tone-deaf, they don't even know what they are missing! The only way to bridge this gulf, Snow wrote, "is by rethinking our education."

And that is why this symposium is so important. It will help us to rethink education today to prepare students for tomorrow in a world where the two cultures are merging fast in the wake of our scientific and technological evolution.

I do not believe that the communications problem is as dire as it was in Snow's day. His two cultures are learning to live with each other in this ever-changing world. But, as Thomas Edison once told his associates, "There is a better way to do it. Find it."

Our challenge at this symposium and, indeed, for the future, is to find better ways to merge the two cultures in the interests of achieving our international policy goals and peace and stability in the world.

James Thurber once wrote: "It's better to ask some of the questions than to know all of the answers." With that in mind, let me pose a few questions we might want to keep in mind to guide today's discussions and our future actions.

First, let's ask ourselves how we can further reduce Snow's communications gulf between the two cultures. Scientists and engineers claim that diplomats, trained in the liberal arts, are fuzzy-minded and long-winded in getting ideas across. Diplomats, on the other hand, see their technology-trained colleagues as too detail-oriented, and tending too often to bury issues with facts and figures.

Both sides have a point. Diplomatic language can, indeed, be tedious, ambiguous and obscure at times. And scientific and technical language can be incomprehensible to those not trained to understand it. Surely, we can figure out ways to enable both sides to better understand each other.

Second — and this is related intimately to the first question — how can we better promote meaningful dialogue to allay the sensibilities and concerns of diplomats, on the one hand; and scientists and engineers, on the other; so that all can work together smoothly to promote our foreign policy goals? This symposium is a fine way to begin, and I hope we will see more events like this in the future.

Third, we need to take a good look at recruiting and training patterns. We need to ask if there are better ways to broaden and diversify the experience and educational bases of people working on both sides of the equation.

I have always believed that walking a few miles in the other person's shoes is a great way to heighten sensitivity and enhance understanding. Certainly, it never hurts to try.

Finally, we should ask: How can we create greater awareness, among practitioners and the public alike, of

the importance of our science and technology assets in advancing America's foreign policy goals?

This last question is intimately connected to the need I spoke of earlier to find ways to integrate science and technology permanently into the fabric of diplomacy.

Some people, including some scientists, engineers and diplomats, never think of our scientific and technical capabilities and products as foreign policy instruments. But they can be powerful tools, indeed, to advance our interests, our goals and our image in the world, as the space program has demonstrated.

For example, even the folks at NASA, including myself, never could have imagined the outpouring of good will and enthusiasm that greeted our Shuttle orbiter Enterprise as she toured Europe in 1983 on the back of a 747.

Hundreds of thousands packed the landing sites in Paris, Rome, Bonn and London as prime ministers and presidents came out to visit the ship. And millions more lined up along highways, in cities and in the countryside to wave and cheer as the 747 dipped low enough for a good view. It was truly a magnificant welcome and it underscored our European friends' deep admiration for America's scientific and technological achievements, as symbolized by our space program.

Clearly, President Reagan recognizes the powerful appeal of science and technology around the globe. And that is why he invited international collaboration on the Space Station.

We have found that international cooperation in space can be a strong unifying force that enhances international cooperation on Earth. Such cooperation not only expands the knowledge base, but serves the cause of international understanding, and ultimately, of peace.

Winston Churchill once said, "Science has given to this generation the means of unlimited disaster or of unlimited progress. There will remain the greater task of directing knowledge lastingly toward the purpose of peace and human good."

That task remains the greatest challenge facing this and future generations. And I have no doubts that we can meet it head-on by continuing to harness the enormous potential of science and technology, coupled with skillful diplomacy, to benefit this nation and people everywhere.

Supercomputer Building Construction Underway

NASA's Ames Research Center, Mountain View Calif., has begun construction on the Numerical Aerodynamic Simulation (NAS) Facility building, to house the world's most powerful supercomputer system.

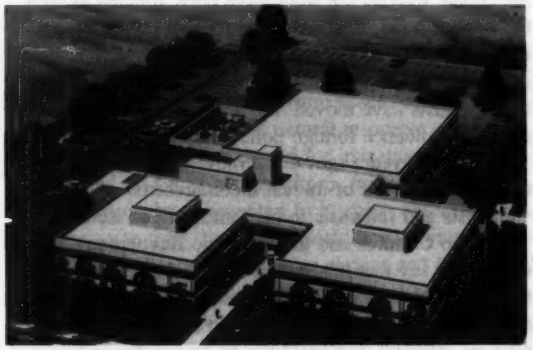
The multicomponent NAS processing system network will provide a national computational capability which will complement NASA's experimental facilities to help maintain national preeminence in aeronautical research.

At the heart of this system, high speed supercomputers will be used to solve complex aerodynamic equations which describe the fundamental fluid physics and large scale aerodynamic flows associated with aircraft flying in the Earth's atmosphere. In effect, aircraft configurations can be tested by "flying" them in the NAS supercomputer system. The NAS will reduce both the time and the costs of developing new aircraft.

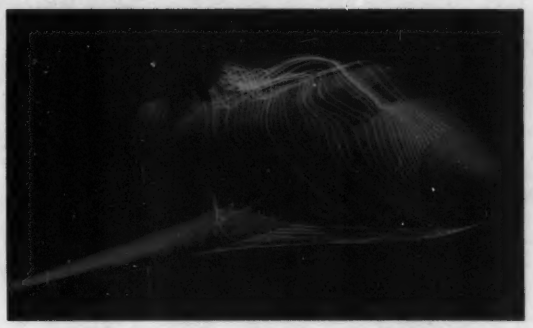
Today's most advanced scientific computers do not have the speed and memory capacity to predict all aspects of aircraft performance. NASA hopes its NAS program will push the supercomputer industry to develop faster, more powerful computers to further advance aerodynamic simulation.

Another important goal of the project is to make the supercomputer network available to remote users in universities, private industry and other government research agencies nationwide. Off-site scientists will gain access to the system by satellite. Other research to be supported by NAS includes computational materials and structures, weather predictions, computational chemistry, genetic engineering and computational astrophysics.

Cray Research's Cray 2 supercomputer, with an expected operating speed of 250 million calculations per second when working aerodynamic problems, is one of



Architect's rendering of the NAS at Ames.



A computer-generated picture shows air flow around the Space Shuttle. Researchers will use supercomputers that can calculate up to a billion operations per second to solve complex equations that predict the pattern of airflow around proposed aircraft designs.

the fastest computers in the world and will be the heart of the initial NAS network when it becomes operational in mid-1986. NASA intends to incorporate even faster supercomputers as they become commercially available, keeping the NAS at the forefront of aerodynamic innovation. NASA goals for the future include supercomputers with up to 1 billion calculations per second in 1988 and 10 billion calculations per second in the 1990s.

The layout of the NAS building was designed to promote a unique interaction between the users and the operators of the system. Scientists who use the computers for their research will be able to work closely with the people who will operate, maintain and develop the NAS system. In essence, NASA hopes to create a partnership between people and machines that, in itself, will advance computer simulation.

The 90,500-square-foot concrete NAS building was designed by Hunt and Co., architects, San Francisco. The contractor is Perini Co., San Francisco.

Six Industry Teams Selected for Space Station Preliminary Design

Six industry teams have been selected for definition and preliminary design of elements of a permanently manned Space Station to be operational in low-Earth orbit by the mid 1990s.

The contracts, that began April 15, extend for 21 months and will cover Space Station elements that have been assigned to four NASA centers.

The responsible NASA center and the industry teams selected were:

Marshall Space Flight Center — **Boeing Aerospace Co.,** Seattle; and **Martin Marietta Aerospace,** Denver.

Goddard Space Flight Center — **RCA Astro Electronics,** Princeton, N.J.; and **General Electric Co., Space Systems Division,** Philadelphia.

Lewis Research Center — **Rockwell International, Rocketdyne Division,** Canoga Park, Calif.; and **TRW Federal Systems Division,** Redondo Beach, Calif.

In addition, NASA has negotiated with **Lockheed Missiles & Space Co.,** Sunnyvale, Calif.; **McDonnell Douglas Astronautics Co.,** Huntington Beach, Calif.; and **Rockwell International, Space Station Systems Division,** Downey, Calif.; the three proposers for work to be performed under the management of the Johnson Space Center. Following negotiations, a report will be presented to the NASA Administrator who will then award one or more contracts.

In addition to the definition and preliminary design of the permanently manned Space Station, contractors are studying how those elements of the Space Station would change were the station originally man-tended rather than permanently manned. Contractors also will pay particular attention to the recommendations of the NASA Advanced Technology Advisory Committee which has identified automation and robotic technologies that could be used in the Space Station.

Following completion of the contracts, NASA plans to move, in 1987, into final design and development (Phase C/D) of the Space Station.

The work managed at each center covers:

Marshall — Definition and preliminary design of pressurized "common modules" which can be equipped with appropriate systems for use as laboratories, living areas and logistic transport; environmental control and propulsive systems; a plan for equipping a module as a laboratory and additional ones for possible use as logistics modules; and a plan for accommodations for orbital maneuvering and orbital transfer vehicles.

Johnson — Definition and preliminary design of the structural framework to which the various elements of the Space Station will be attached; interface between the Space Station and the Space Shuttle; mechanisms such as the Remote Manipulator Systems; attitude control, thermal control, communications and data management systems; plan for equipping a module with sleeping quarters, wardroom and galley; and plan for extravehicular activity.

Goddard — Definition and preliminary design of the automated free-flying platforms and of provisions to service, maintain and repair the platforms and other free-flying spacecraft; provisions for instruments and payloads to be attached externally to the Space Station; and plan for equipping a module as a laboratory.

Lewis — Definition and preliminary design of the electrical power generation, conditioning and storage systems.

NASA will retain the responsibility for overall program definition and plans to retain responsibility for systems engineering and integration throughout the program. This effort will be managed at the Johnson Space Center.

NASA's plans call for a Space Station to be operational by the mid 1990s. It will be capable of growth both in size and capability and is intended to operate well into the 21st century. It is planned to be placed in low-Earth orbit, about 300 miles high, and at an inclination to the equator of 28.5 degrees. It will include a number of pressurized modules and a power supply of about 75 kilowatts, support a crew of six to eight people and have two or more free-flying platforms.

For the purpose of the definition and preliminary design activity, NASA has selected a Space Station reference configuration called the "power tower." This is one of a family of configurations that uses similar elements or components. The power tower family is considered a starting point for the definition studies and is expected to undergo significant modifications as the studies progress. Contractors may offer modifications within the reference concept family or other preliminary designs.

Launch of the Space Station elements and subsequent transportation between the Earth and station will be provided by the Space Shuttle.

A major objective of the Space Station Program is to bring about participation of international partners as builders and users as well as to assist in Space Station operations. The European Space Agency, Canada and Japan have indicated interest in participating in the Space Station program. Funding for such international participation will be provided by the other governments who will award their own definition and preliminary design contracts in phase and in coordination with the NASA activity.

Howard University Awarded Grant for Space Structure Research

NASA has awarded the Howard University School of Engineering Large Space Structure Institute (LSSI) in Washington, D.C. an on-going grant expected to total $1.9 million to develop theoretical knowledge supporting the design and construction of very large space systems.

Information accumulated from the grant to Howard's Institute is expected to make a significant contribution to the establishment of large space stations and space settlements.

The LSSI research project will help demonstrate the practical benefits of U.S. space capability. One potential application could include construction of a solar power satellite converting the sun's energy into electricity for transmission back to Earth. Another could include constructing large platforms that would allow scientists to observe the Earth for a better look at weather and to measure the ground water table. Still another application could be to develop structures from which the salinity of the oceans and their temperatures could be measured which would allow scientists to monitor the migrations of fish.

The LSSI research team consists of Dr. Taft H. Broome, chief project investigator and chairman of the Department of Civil Engineering; Howard University faulty members; and one faculty member each from the Massachusetts Institute of Technology, Cambridge, and Rensselaer Polytechnic Institute, Troy, N.Y. Graduate students from the latter institutions also will participate.

"This provides a unique opportunity for minorities and women to take their place at the cutting edge of a new technology, preparing them for jobs in either the public or private sector," according to Dr. Broome.

At this point NASA is primarily interested in the concept development, research and demonstration analysis being undertaken by LSSI. Once Broome and his research team have provided the agency with the needed data, NASA could turn the project over to private industry for implementation.

The on-going grant will allow Howard University to be one of the leading institutions in the development of large space structures.

NASA Participates at Paris Air Show

"Living, Learning, Working in Space" is the theme of NASA's exhibit at the 36th Paris Air Show, Le Bourget, France.

Located in the U.S. Pavilion, NASA's exhibit will highlight fullscale elements of a space station, including mockups of working and living quarters.

As visitors walk through the 6,900-square-foot exhibit area, audiovisual presentations will depict life inside a

space station. A large model of the "power tower" configuration space station along with models of future U.S. space science programs, such as Space Telescope and Galileo, will be suspended in a diarama, giving viewers the impression that they are looking out into space from a space station module.

Exhibits will also showcase NASA's latest aeronautical research at this year's air show which runs from May 30 until June 9.

Marshall Property Specialist Honored for Information System Development

A Marshall Space Flight Center industrial property specialist has been awarded a cash award by NASA Headquarters for his development of the NASA Industrial Property Management Information System (NIPMIS).

Mel Potts of the Industrial Property Management Branch of the Management Operations Office was nominated for a $1,000 Headquarters cash award by John W. Gaff, chief of the Supply and Equipment Management Branch at NASA Headquarters.

"Potts designed and implemented NIPMIS on his own initiative . . . for local management purposes at Marshall," said Gaff in his letter of nomination. "Headquarters and other centers soon took note of the immediate and potential benefits that NIPMIS offered."

Potts then collaborated with Headquarters and Johnson Space Center officials to make the system generic for the use of other centers and compatible with hardware being provided to the centers as part of the NASA Equipment Management System.

Mel Potts (center) of the MSFC Management Operations Office receives Special Achievement Award from Jeff Sutton (right) of the NASA Headquarters Supply Management Branch, and J.N. Foster, Director of Marshall's Administration and Program Support Directorate.

As a result of these activities, NIPMIS now is being used at Marshall and Johnson, and is being implemented at Headquarters, Langley Research Center, Ames Research Center and Goddard Space Flight Center.

"Through Potts initiative and continuing dedication, the agency now has an automated system providing an improved overview of $5 billion of property resources held by NASA contractors," said Gaff. "Moreover, this has been achieved with a corresponding reduction in paperwork and reporting to Headquarters by the centers."

The award, approved by C. Robert Nysmith, NASA Associate Administrator for Management, was presented by Jeff Sutton of the Headquarters Supply and Equipment Management Branch, and J.N. Foster, Director of Marshall's Administration and Program Support Directorate.

Ames Wins Equal Opportunity Award

Ames Research Center, Mountain View, Calif., is the recipient of NASA's Equal Opportunity Plaque and Equal Opportunity Trophy for 1984. The annual award recognizes the NASA installation which has implemented the most effective management strategies and achieved the most positive affirmative action results.

NASA Administrator James M. Beggs and Ames Center Director William F. Ballhaus Jr. display award.

NASA Administrator James M. Beggs stated, in announcing the award, that of the 42 factors involved in rating centers, Ames rated first in nine and second in six. The factors included increases in minorities and women in scientific, engineering, administrative and supervisory positions. The amount and percent of Ames' procurement dollars going to minority businesses increased and the outreach activities encouraging the involvement of the handicapped, disabled veterans, minorities and women in NASA programs multiplied by an impressive rate.

Beggs presented the award which reads "In recognition of well-planned and executed management strategies which have contributed significantly to the employment, development and utilization of minorities, women and handicapped at NASA and which have shared the agency's resources with a broader array of American citizenry."

The plaque and trophy were presented on March 1. Previous winners of the award are Goddard Space Flight Center, Johnson Space Center, with Langley Research Center and Headquarters sharing the award last year.

Ames Forms Artificial Intelligence and Automation Sciences Group

Ames Research Center, Mountain View, Calif., has been designated NASA's lead center in artificial intelligence research and has named a group to do basic and applied research in artificial intelligence, automation sciences and space-related computer science technology. Headed by Dr. Henry Lum, the group has been designated as the Information Sciences Office and will stress applications to the Space Station.

Research will include artificial intelligence programming languages, expert systems development, knowledge representation and information understanding, machine vision and learning, sensor fusion, and optical processing.

The space-related, computer-science research will focus on: symbolic processing and data flow architectures; network design, protocols, and simulation; and optical read/write information storage technology.

Office research goals and objectives will be accomplished through a combination of in-house research and a cooperative team of outside research organizations from industry and academia. In-house efforts will focus on applied research and the development of flight experiments to validate and demonstrate the technologies being developed. The cooperative research team activities will center around basic or fundamental research issues.

Cooperative team researchers will be working under NASA grants and contracts to research team member organizations. Such organizations are SRI International; Symbolics Inc.; Innovative Optics, Inc.; Stanford University; University of California, Berkeley; Massachusetts Institute of Technology; University of Texas and University of Michigan.

Expertise of the office staff will be enhanced by both formal academic studies and on-site experience gained through "apprenticeship programs." These will be conducted at the facilities of the cooperative research team members. Duration of the apprenticeships are from 6-12 months. Three office researchers are currently participating in the program.

Research of the Information Sciences Office will be oriented toward the user community, primarily other NASA centers, with focus on both technology development for user applications and help to users during implementation. Space Station automation is the primary application. Agreements have been initiated with Johnson Space Center, Houston and Goddard Space Flight Center, Greenbelt, Md., to work together in the implementation of artificial intelligence technology for Space Station automation.

The office has also been advising on Space Station automation through participation of several NASA advisory groups, such as the Space Station Automation Study Team, Space Station Automation and Robotics Panel, Advanced Technology Automation Committee, and NASA Headquarters Space Station Data Systems Steering Committee.

The office has also received approval for the conceptual development of a Space Missions for Automation and Robotics Technology (SMART) Program. This will be a multi-flight Space Shuttle and Space Station automation and robotics test facility for the validation of advanced robotics, automation, and telepresence technologies in a realtime operational environment.

The facility will be upgraded periodically by the research team organizations and available to all potential investigators. Other user-related accomplishments to date include the development and successful implementation of expert systems for an astrophysics mission scheduler and a particle classifier for aerosol particulates obtained from upper atmospheric research flights, as well as technical consultation to the Army Aeromechanics Laboratory at Ames for automation of the helicopter environment.

The office has established cooperative efforts with the Ames Aerospace Human Factors Research Division and

with the Research Institute for Advanced Computer Science (RIACS). This will allow for joint investigation into man-machine interface research issues associated with autonomous systems, and the establishment of a high-speed data communications link with RIACS for resource sharing.

Rare Alignment of Pluto and Its Moon Providing Astronomy Opportunity

A rare alignment of Pluto and its only known satellite, Charon, in which they take turns eclipsing each other, is giving astronomers a new tool to study the solar system's most distant planet.

Astronomers at NASA's Jet Propulsion Laboratory (JPL), the University of Hawaii, the University of Arizona and the University of Texas are observing Charon as it alternately moves in front of and then behind Pluto in a rare series of eclipses that occur every 124 years or twice in each orbit of the sun.

Each time Charon passes between Pluto and Earth, a portion of the surface of Pluto is blocked from view, resulting in a dimming of the combined light from the two bodies. When Charon moves behind Pluto, their roles are reversed.

Measurements of the times, durations and changes in brightness of the events will allow astronomers to calculate the masses, diameters and densities of both Pluto and Charon. A more accurate estimate of the density of Pluto and Charon would allow astronomers to develop models of the planet's and satellite's composition. Estimates of Pluto's density now have an uncertainty of 50 percent, which is not accurate enough to derive information on its components. Pluto's density is thought to be about that of water. That would make it the lowest-density, solid surface planet known.

The new measurements indicate that the combined brightness of Pluto and Charon diminishes by 4 percent during the eclipses. The dimming lasts about 2 hours and is superimposed on a 30 percent brightness change that occurs over a 6.4-day period. The longer change in brightness happens because one hemisphere of Pluto is 30 percent brighter than the other.

Very little is known about Pluto and even less about Charon. No one knew, for example, when or even if the 5-year-long series of eclipses would begin. (This is the first opportunity to observe the eclipse series since Pluto was discovered in February 1930). So that they would not miss any of the earliest events, the astronomers established an observing network. The network is made up of astronomers at McDonald Observatory in Texas, the University of Arizona observatories, Palomar Observatory in California and Mauna Kea Observatory in Hawaii.

The first to see and measure an eclipse of Pluto by Charon was Dr. Edward Tedesco of JPL, while observing with Dr. Bonnie Buratti, also of JPL, at Palomar on Jan. 16, 1985. On Feb. 17, Richard Binzel observed another eclipse from the University of Texas' McDonald Observatory. And Dr. D.J. Tholen observed a third eclipse on Feb. 20 from the Mauna Kea Observatory.

Astronomers discovered Charon in 1978. Charon's orbital motion around Pluto led the astronomers to realize that Pluto is tipped on its side, in much the same way as Uranus, so that Pluto alternately points its north and then its south pole toward the sun.

Pluto circles the sun in a highly elliptical orbit that moves inside of Neptune's orbit and then far beyond it. It has been inside the orbit of Neptune since 1979 and will be there until 1999. Its average distance from the sun is 4 billion miles, almost 40 times greater than Earth's. Pluto was discovered in February 1930 by Clyde Tombaugh at the Lowell Observatory. Charon was discovered in 1978 by James Christy at the U.S. Naval Observatory. Because it circles the sun only once in 248 years, Pluto has not completed 1 orbit since its discovery. Their great distance and relatively small sizes make Pluto and Charon among the most difficult objects to observe in the solar system.

AXAF Scientific Investigations Selected

NASA has selected scientific investigations to be implemented on the proposed Advanced X-ray Astrophysics Facility (AXAF).

The AXAF will be a long-lived X-ray observatory operating in low-Earth orbit for at least 15 years. The basic observatory consists of a 1.2-meter diameter, 10-m focal length X-ray telescope housed within a spacecraft carrying an array of selected instruments and providing power, precise pointing and data transmission. AXAF will make detailed observations of the X-ray emissions from cosmic sources ranging from nearby stars to distant quasars.

Construction of AXAF could begin as early as 1987-1988 with launch approximately 5 years later. In orbit, AXAF will join the Hubble Space Telescope, to be launched in 1986, and the Gamma Ray Observatory, planned for launch in 1988. These three space observatories, together with the later launch of the

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planned Space Infrared Telescope Facility, will provide the capability for simultaneous observations of cosmic sources over infrared, visible, ultraviolet, X-ray and gamma ray wavelengths.

The AXAF investigators fall into three catagories: Instrument Principal Investigators, with the responsibility for design and fabrication of scientific instrumentation to be placed in the telescope focal plane; Interdisciplinary Scientists, who provide scientific expertise from both X-ray astrophysics and other fields of astronomy; and a Telescope Scientist, who will provide the scientific and technical expertise essential to the fabrication of the X-ray telescope.

The selected investigators are:

Instrument Principal Investigators

Dr. Gordon Garmire, Pennsylvania State University, "Charged Coupled Device Imaging Spectroscopy."
Dr. Steven Murray, Smithsonian Astrophysical Observatory, "High Resolution Camera."
Dr. Stephen Holt, Goddard Space Flight Center, "X-Ray Spectroscopy Investigation for the AXAF."
Dr. Claude Canizares, Massachusetts Institute of Technology, "High Resolution X-Ray Spectroscopy Using AXAF."
Dr. Albert Brinkman, University of Utrecht, The Netherlands, "High Throughput Transmission Grating for Cosmic X-Ray Spectroscopy."

Interdisciplinary Scientists

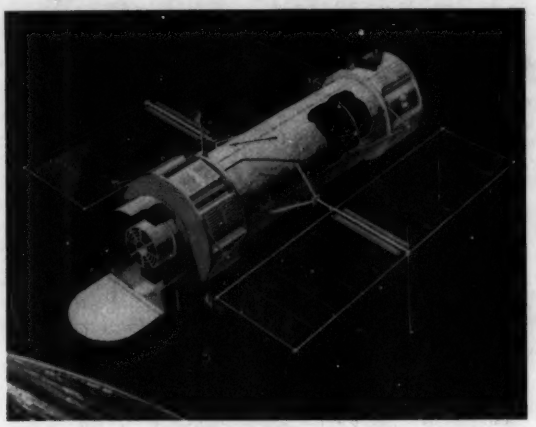
Dr. Riccardo Giacconi, Space Telescope Science Institute, "Advanced X-Ray Astrophysics Facility Mission (AXAF)."
Dr. Jeffrey Linsky, National Bureau of Standards, "The Coronal Structures of Selected Cool Stars and Close Binary Systems."
Dr. Richard Mushotzky, Goddard Space Flight Center, "A Program to Measure the Mass of Galaxies and Clusters of Galaxies with AXAF."
Dr. Andrew Wilson, University of Maryland, "Studies of Radio Jets and the Narrow Line Regions of Active Galaxies with AXAF."
Dr. Andrew Fabian, Cambridge University, United Kingdom, "Cooling Flows in Clusters and Galaxies."

Telescope Scientist

Dr. Leon Van Speybroeck, Smithsonian Astrophysical Observatory.

The selected investigators will be appointed members of the AXAF Science Working Group which will provide scientific and technical guidance to the project through all stages from initial design to on-orbit operation. Each will receive a specific amount of time to use the telescope during the first 30 months after the AXAF is declared operational. The majority of observing time will be made available to astronomers throughout the United States and around the world.

The AXAF project is managed by NASA's Marshall Space Flight Center, Huntsville, Ala., for the Astrophysics Division, Office of Space Science and Applications, NASA Headquarters, Washington, D.C.



An artist's rendering of proposed AXAF project.

NASA Antenna Donated to Tasmania University

NASA has donated a 26-meter antenna, located at the Orroral Valley Tracking Station in Australia, to the Australian University of Tasmania. The Orroral Valley Station ceased operations in December 1984.

The antenna had been used in a variety of NASA and international programs including the Skylab Program, the Apollo Soyuz Test Project and the Space Shuttle Program.

NASA offered to provide assistance for the dismantling and transfer of the antenna to Hobart, Tasmania, Australia.

The University of Tasmania's physics department, one of Australia's major centers for astronomy and astrophysics, will use the antenna as part of its teaching and research activities. One of the planned uses for the antenna is in operation with the Australian telescope presently under construction in New South Wales. This application will dramatically improve the telescope's performance.

The antenna also will be available for very long baseline interferometry in conjunction with other instruments. This is a system which uses a number of separate antennas to construct a radio telescope with a high resolution capability. Using the antenna for interferometry will assist geodynamics and geophysical research by obtaining more accurate measurements of the Earth's surface and will contribute to the data base on the Australian continent.

NASA may use the antenna for its geodesy, geodynamics and astronomy projects in the future.

Commercial Use of Space Pact Signed

A memorandum of understanding was signed by NASA and Grumman Corp., Bethpage, N.Y., for the development of a materials processing in space research program.

Issac T. Gilliam IV, Assistant Administrator for Commercial Programs, NASA Headquarters, stated that the agreement is in keeping with President Reagan's reaffirmed commitment to the commercial use of space and represents Grumman's first step towards becoming an active participant with NASA in the commercial development of space.

Grumman will pursue experiments involving directional solidification of gallium arsenide, other semiconductor materials, various metals and alloys. The process is applicable to the production of semiconductor crystals and magnets for electrical motors. Under this agreement, a preliminary document, Grumman's work will focus on semiconductor materials.

Directional solidification uses precisely controlled temperatures to melt and then solidify a material. During the process, the materials's crystalline structure or molecular arrangement is aligned in a fashion that should virtually eliminate any imperfections in the compound. Important implications of the technology is that "flawless" semiconductor crystals would yield a greater quantity and quality of microcircuit chips, leading to higher speed electronic devices that consume less power, and even greater miniaturization.

In the agreement, both NASA and Grumman pledge support of their mutual interests in materials processing through the exchange of information. Further discussions should lead to agreement later this year regarding specific flight plans for Grumman to conduct its materials processing experiments aboard the Space Shuttle.

General Electric Awarded UARS Contract

NASA awarded a $145.8 million contract to the General Electric Co.'s Valley Forge Space Center, Philadelphia, for the development of the Upper Atmosphere Research Satellite (UARS) observatory.

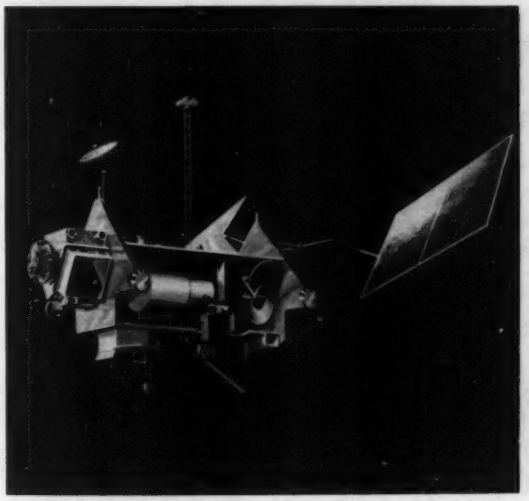
The UARS will carry 10 scientific instruments into a 373-mile circular orbit after deployment from the Space Shuttle. Launch is scheduled for October 1989.

With many of its remote sensing instruments providing essentially global coverage, UARS will provide data necessary to understand the composition and dynamics of the upper atmosphere for the first time.

A better understanding of this atmospheric region is important in solving many outstanding questions about the Earth's weather and climate.

As an example, UARS will provide previously unavailable insight into the nature of the natural and human effects on ozone, a gaseous form of oxygen which protects us from the harmful ultraviolet rays of the sun. Ozone is found in the stratosphere, a delicate layer of the atmosphere surrounding the Earth at a distance of from 9 to 31 miles.

NASA's Goddard Space Flight Center, Greenbelt, Md., will provide project management for the Office of Space Science and Applications, NASA Headquarters, Washington, D.C.



An artist's concept of UARS project.

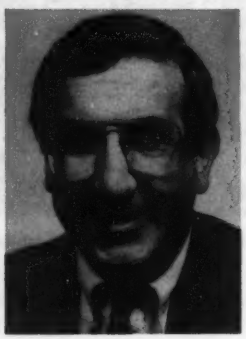
Key Personnel Announcements

Dr. David C. Black, Research Scientist, Theoretical Studies Branch, Ames Research Center, has been detailed to NASA Headquarters for one year as the new chief program scientist for the Office of Space Station. He will report to the Associate Administrator for Space Station and serve as an advisor on all matters pertaining to scientific utilization of the Space Station. He will respond to events or concerns about the Space Station raised by the general scientific user community.

Black is currently a member of the Task Force on Scientific Uses of the Space Station and the National Academy of Sciences Study on "Space Sciences, 1995-2015." Since 1972, he has served as a research scientist in the Theoretical Studies Branch, Space Science Division, at Ames. During this period, he has also served as acting chief of the Theoretical Studies Branch, and as acting deputy chief of the Space Science Division.

Black has a B.S., an M.S. and a Ph.D. in physics from the University of Minnesota. He has served as a member and chairman of the Ames Basic Research Council since its formation in 1980. He was a member of the Space Astronomy Panel of the California Space Institute (1979-80), and is a member of the Executive Committee of the Space Science Laboratory at the University of California; the Space and Earth Science Advisory Committee; and the Space Telescope Working Group in Solar System Science. He has published more than 80 articles in reference journals. Black is editing a book "Protostars and Planets II" to be published this spring, and authoring a book for the CRC Press' Uniscience Series.

David C. Black



Milton A. Silveira

Dr. Milton A. Silveira, NASA's Chief Engineer has been named the agency's competition advocate. Silveira will be responsible for recommending annual goals and objectives, approving organization and personal accountability, assuring training and reviewing noncompetitive procurements in order to remove constraints to competition.

Silveira has established the Office of Competition Advocacy within the Office of the Chief Engineer and has assigned David Austin as the principal staff member. A forthcoming NASA management instruction will designate each deputy center director as the center competition advocate.

NASA competitively awarded 72 percent of the amount spent on procurement actions in fiscal year 1984. This represented a significant increase over the 1983 fiscal year, when competitive awards accounted for 68.8 percent. The agency anticipates a continuing upward trend in fiscal year 1985.

NASA has demonstrated national leadership in achieving productivity objectives during the past few years. Thus the objective, as directed by Congress and the Executive Office, of increasing competition is a realistic approach to improving productivity and quality. Pursuit of increased competition requires sound judgement, intelligent thinking, and a working knowledge of the market as essential elements for success. In an environment such as government procurement of specialized systems, (i.e., space, defense, planetary exploration, communication, nuclear) the government has an obligation to provide for and maintain a viable industrial base. In addition, as stewards of the taxpayer's funds, government must ensure that it gets the right product, on time, with the necessary level of quality and at the right price. To satisfy these requirements, full and open competition is a desirable approach for NASA procurement.

What's New in NASA Radio and Television Programming

The 4½-minute radio program "Space Story" will now be broadcast once a week via satellite to all major radio networks. Satellite distribution makes it possible to update or change programs, if necessary, and to inform stations quickly of upcoming important events or breaking news stories. The new system will eventually replace the tape-and-mail distribution, reach a larger audience and reduce costs.

At the same time a new Broadcast News Service has begun using a telephone feed for breaking news stories. By calling 202/737-6911, a station can record an actuality or interactive interview for use in their news broadcast. The NASA Space Story can be heard on the NASA satellite on Fridays at 2 p.m. EST.

Radio programs released in March:

Space Story (4½-minute programs):

"Powering the Space Station" (featuring Dr. Henry Brandhorst, Lewis Research Center)
"Kennedy Space Center . . . Today and Tomorrow" (featuring Richard Smith and Robert Sieck, Kennedy Space Center)
"The Age of the Universe" (featuring Riccardo Giacconi, Director, Space Telescope Science Institute)
"A New Culture in Space" (featuring Jesco Von Puttkamer, NASA Headquarters)

Special Report (14½-minute program):

"Search and Rescue Satellite" (featuring Fred Flatow, Goddard Space Flight Center)

NASA's "Aeronautics and Space Report" television series has a new 14½-minute "magazine" format that will be released quarterly. The first videotape was completed and mailed to television stations at the end of January. Three-quarter-inch videotapes are available at each center Public Affairs Office. This first release includes four separate features:

- XV-15 Tiltrotor.
- A story dealing with the possibility of a permanent lunar base.
- Food for Space — a look at space food preparation yesterday and today.
- 1984 Space Shuttle Highlights.

NASA's own Indiana Jones — Goddard Space Flight Center scientist Mark Imhoff leads a team of woodcutters/fishermen down a river near Supoti Forest Station, Bangladesh, to survey sites for radar reflectors for the Shuttle Imaging Radar (SIR-B) experiment. SIR-B, a synthetic aperture radar, flew on mission 41-G in October 1984, producing black-and-white images from data collected by transmitting and receiving millions of microwave impulses. Imhoff's experiment was to find out if SIR-B images could be taken through dense jungle vegetation. Imhoff, in his 7-week adventure, encountered heavy storms, poisonous snakes, crocodiles, disease and tigers — one tiger killed a member of his Bengali support staff. Imhoff returned Nov. 12, completing a successful mission and an unforgettable experience.

Mission 51-B — Pre-launch profile

Crew: Bob Overmyer, Commander
Fred Gregory, Pilot
Don Lind, Mission Specialist 1
Norm Thagard, Mission Specialist 2
Bill Thornton, Mission Specialist 3
Lodewijk van den Berg, Payload Specialist
Taylor Wang, Payload Specialist

Orbiter: Challenger (OV-099)

Launch Site: Kennedy Space Center, Pad 39A

Launch Date/Time: April 29, 1985; Noon EDT*

Orbital Inclination: 57 degrees

Altitude: 190 nautical miles

Mission Duration: 6 Days, 20 hours, 58 minutes*

Orbits: 108 full orbits; landing on 109th

Landing Date/Time: May 6, 1985; 8:58 a.m. EDT*

Landing Site: Kennedy Space Center, Fla.

Payload: Spacelab 3

Experiments: **AFT** (Autogenic Feedback Training)
ATMOS (Atmospheric Trace Molecules Spectroscopy)
BTS (Biotelemetry System)
DEMS (Dynamic Environment Measuring System)
DDM (Drop Dynamic Module)
FES (Fluid Experiment System)
GFFC (Geophysical Fluid Flow Cell)
IONS (Ionization States of Solar and Glactic Cosmic Ray Heavy Nuclei)
MICG (Mercuric Iodide Crystal Growth)
RAHF-VT (Research Animal Holding Facility Verification Test)
UMI (Urine Monitoring Investigation)
VCGS (Vapor Crystal Growth System)

* Subject to change

Payload Data

VMFC — The Very Wide Field Camera will make a general survey of a large part of the celestial sphere. The objectives are to study galactic and faint extragalactic extended sources and peculiar ultraviolet in a photometric and spectrometric modes.

NUSAT — The NUSAT is an experiment to demonstrate the capability for measuring the antenna patterns of Air Traffic Control Radar Beacons operated by the Federal Aviation Administration, U.S. military services and foreign governments. The payload will be mounted inside a gas canister located in front of the spacelab module.

GLOMR — The Global Low Orbiting Message Relay is a satellite that is structurally similar to NUSAT. It will be used by the U.S. Navy to assist in the relaying of data from the Navy's buoy system. The 150 pound, 62 sided polyhedron will be ejected from the bay in the same manner and within 20 minutes of NUSAT.

Experiment Data

AFT — Crewmembers will be trained preflight in autogenic feedback. On orbit, crewmembers will practice feedback during zero-g motion sickness attacks, using monitoring instruments and data recorders.

ATMOS — This investigation will use infrared spectroscopy to study the chemistry and physics of the upper Atmosphere, and attempt to determine its compositional structure. Sunlight passing through the upper atmosphere will be read with an interferometer.

DEMS-BTS — These investigations will provide support data for RAHF-VT. DEMS will measure noise, vibration and accelerations on specimens during launch and entry. The BTS will measure physiological functions of specimens. Sensor packages will be implanted in specimens, and data will be telemetered to an RAHF antenna.

DDM — The Drop Dynamic Module will study the equilibrium figures of rotating drops, and large-amplitude oscillations of liquid drops.

FES — This system is used to grow triglycine sulfate crystals by removing heat from a saturated solution through a seed crystal. The intention is to develop a technique for crystal growth in microgravity, while considering the growth environment in relation to growth behavior.

GFFC — The purpose of this experiment is to study global atmospheric processes and flows of rotating planets and stars via laboratory models. The GFFC consists of a dialectric fluid between two concentric, rotating electrically conducted spheres.

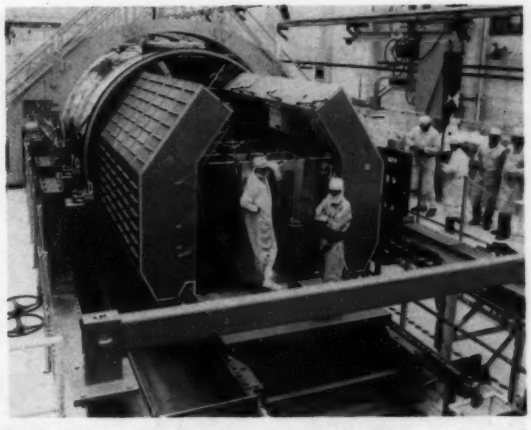
IONS — This experiment will study low-energy cosmic ray ions of various basic elements to measure their ionic state. A detector system, consisting of layers of plastic, will show a trail of penetration and translation by cosmic rays.

MICG — The intent of this experiment is to grow near-perfect mercury-iodide crystals in a two-zone furnace.

RAHF-VT — The RAHF is designed to support animals from rodents to small primates. The intention is to verify the facility from both a technical and habitability standpoint.

UMI — The investigation is designed to record water intake of crewmembers, and use a urine monitoring system to measure urine volume of each crewmember.

VCGS — The purpose of this experiment is to grow near-perfect crystals of mercuric iodide, using a vaporization/condensation technique. A special furnace will be used to grow the crystals by vaporization and recondensation at approximately 110 degrees C.



Experiment racks and flight floor are moved inside the outer shell of the pressurized module that will comprise part of the Spacelab 3 payload.

Patents for Inventions from NASA Research

The Office of General Counsel, NASA Headquarters, announces the following U.S. patents have been issued by the U.S. Patent Office and Trademark Office to NASA for inventions resulting from NASA research. Inquiries concerning them should be directed to the attention of the NASA Patent Counsel of the indicated installation.

Inventor(s) & Employer	Title	Patent No.	Installation
Anne D. St. Clair, Terry L. St. Clair, NASA/LaRC	Elastomer toughened polyimide adhesives	4,497,935	LaRC
James B. Breckinridge, Norman A. Page, Caltech/JPL	Optical system	4,497,540	NRO-JPL
Richard W. Lauver, NASA/LeRC	Chemical approach for controlling Nadimide cure temperature and rate with Maleimide	4,497,948	LeRC
Richard W. Lauver, NASA/LeRC	Chemical approach for controlling Nadimide cure temperature and rate with Maleimide	4,497,939	LeRC
Richard W. Lauver, NASA/LeRC	Chemical approach for controlling Nadimide cure temperature and rate	4,497,940	LeRC
James L. Rand, Southwest Research Institute	Thin film strain transducer	4,498,231	LaRC

April marks the 25th anniversary of U.S. weather satellites. On April 1, 1960, the Television and Infrared Observation Satellite (TIROS I), the first true weather satellite, was launched from Cape Canaveral. TIROS was a simple hatbox-shaped craft carrying special television cameras that viewed Earth's cloud cover from a 450-mile orbit. The pictures radioed back to Earth provided meteorologists with a new tool for advanced knowledge of weather systems and commenced an era of technology invaluable to mankind.

1985 Launch Activity

Space Shuttle Launches

Date	Mission	Orbiter	Launch Site*	Remarks
Jan. 24	51-C	Discovery (OV-103)	KSC	Dedicated Department of Defense flight; successful launch; KSC landing Jan. 27.
April 12	51-D	Discovery (OV-103)	KSC	Payload: Syncom IV-3, Telesat-I.
April 29	51-B	Challenger (OV-099)	KSC	Payload: Spacelab 3.
May 30	51-G	Discovery (OV-103)	KSC	Payload: Spartan-1, Telstar 3-D, Morelos-A, Arabsat A.
July 9	51-F	Challenger (OV-099)	KSC	Spacelab 2.

Satellite Deployments from the Shuttle

Date	Satellite	Deployment Device/ Upper Stage**	Shuttle Mission	Remarks
April 12	Telesat-I	PAM-D	51-D	Canadian communications.
April 13	Syncom IV-3	UUS	51-D	Hughes communications.
May 30	Morelos-A	PAM-D	51-G	Mexican communications.
May 31	Arabsat-A	PAM-D	51-G	Saudi Arabian communications.
June 1	Telstar 3-D	PAM-D	51-G	AT&T communications.
June 2	Spartan 101	RMS	51-G	NASA experiment structure.

Expendable Launches

Date	Mission	Launch Vehicle	Launch Site*	Remarks
March 22	Intelsat VA-F10	Atlas Centaur	ESMC	Intelsat communications; launch successful.
2nd Qtr.	AF-16	Scout	WFF	U.S. Air Force.
2nd Qtr.	Navy-22	Scout	WSMC	U.S. Navy.
May 5	Intelsat VA-C	Atlas Centaur	ESMC	Intelsat communications.
2nd Qtr.	Navy-23	Scout	WSMC	U.S. Navy.
August	Intelsat VA-D	Atlas Centaur	WSMC	Intelsat communications.
August	NOAA-G	Atlas	WSMC	National Oceanic and Atmospheric Administration weather satellite.
3rd Qtr.	AF-17	Scout	WFF	U.S. Air Force.
October	GOES-G	Delta	ESMC	NOAA environmental satellite.
4th Qtr.	San Marco	Scout	SMR	NASA cooperative with Italy.

* **Launch Sites:** KSC — Kennedy Space Center, Fla.; ESMC — Eastern Space and Missile Center, Fla.; SMR — San Marco Range, Indian Ocean; WSMC — Western Space and Missile Center, Vandenberg Air Force, Base, Calif.; WFF — Wallops Flight Facility, Wallops Island, Va.

** **Upper Stages:** IUS — Inertial Upper Stage; PAM-D — Payload Assist Module; UUS — Unique Upper Stage; RMS — Remote Manipulator System.

Another Dividend from Air and Space

Research and development in aeronautics and space have provided numerous benefits for all Americans — and at a tiny percentage of the tax dollar. Here is an example:

Portable X-Ray Device

A portable X-ray instrument developed by NASA and now being produced commercially as an industrial tool has found further use as a medical system. The instrument is Lixiscope — Low intensity X-ray imaging Scope — a self-contained, battery-powered fluoroscope that produces an instant image through use of a small amount of radioactive isotope; it is designed to use less than 1 percent of the radiation required by conventional X-ray devices.

Originally developed by Goddard Space Flight Center, Lixiscope is being produced by Lixi, Inc., Downers Grove, Il., which has an exclusive NASA license for one version of the device. Lixi, Inc., has received Food and Drug Administration approval to begin testing the device for medical applications, the first step toward its adoption as a clinical instrument.

The unit's portability allows its emergency use in field situations where immediate fluoroscopic examination is indicated, for example, scanning for possible bone injuries to athletes (above). Lixiscope's small size and low radiation dosage makes it attractive in other applications, such as emergency room examination of small children to avoid the necessity for taking them to the x-ray department (below). The instrument also has applications in dentistry and orthopedic surgery.

Lixiscope is finding growing acceptance as an industrial tool in the United States and abroad; it is used mostly for rapid non-destructive testing — instant detection of product flaws without waiting for development of X-ray film. It is also used in security applications, such as examining parcels in mail rooms and building entries.

* NASA does not endorse commercial products developed as a result of its Technology Utilization or Patent Licensing Programs, but it does encourage the widest possible use of its technology.